

SECTION 711 -- CONCRETE BRIDGE DECK REPAIR WITH HIGH DENSITY-LOW SLUMP CONCRETE

711.01 -- Description

1. This work shall consist of repairing the existing concrete bridge deck, resurfacing with high density-low slump concrete, and other incidental work shown in the plans.
2. A pre-placement conference at a time mutually agreed upon shall be held before the initial placement.

711.02 -- Material Requirements

1. All materials shall conform to the requirements in Table 711.01.

Table 711.01

Material Requirements	
Applicable Materials	Section
Portland Cement Concrete	1002
Curing Materials	1010, 1011
Fine Aggregate for Concrete Bridge Deck Overlays	1033
Coarse Aggregate for Concrete Bridge Deck Overlays.....	1033
Water for Concrete.....	1005

2. The concrete for bridge deck repair and resurfacing shall be High Density-Low Slump Concrete, and it shall be proportioned and mixed at the job site.
3.
 - a. Grout for bonding new concrete to existing concrete shall consist of equal parts by weight of portland cement and sand, mixed with sufficient water to form a stiff slurry. The consistency of this slurry shall be such that it can be applied using a broom or brush in a thin, even coating that will not run or puddle in low spots.
 - b. For sealing vertical joints, this slurry may be thinned to a consistency similar to common house paint.
 - c. Sand used for grout shall meet the following gradation requirements in Table 711.02.

Table 711.02

Grout Sand Gradation		
Percent Passing		
Sieve Size	Target Value	Tolerance
No. 4	100	None
No. 10	85	± 5
No. 30	57	±18
No. 200	3	± 3

711.03 -- Equipment

1. Machines with oil leaks or drips shall not be used on the prepared deck surface.

2. Surface preparation equipment shall be of the following types:

a. Concrete saws capable of sawing to a specified depth.

b. Scarifying equipment capable of uniformly cutting the existing concrete surface to the depths required.

c. Sandblasting equipment able to remove rust and concrete from exposed reinforcing bars. The equipment shall also be able to remove loose or fractured particles from the prepared concrete surface.

d. Power-driven hand tools will be allowed with the following restrictions:

(1) Jackhammers weighing more than a nominal 60 pound class shall not be used.

(2) Jackhammers or chipping tools shall not be operated at an angle greater than 45 degrees measured from the deck surface.

(3) Chipping hammers weighing more than the 30 pound class shall not be used to remove concrete from beneath reinforcing bars in Class II Repair.

3. The proportioning and mixing equipment shall be a self-contained, mobile, continuous-type mixer complying with the requirements of Section 1002.

4. a. The placing and finishing equipment shall include adequate hand tools for brooming in the grout and for distributing the stiff, plastic mix and working it down to approximately the correct level for striking off with the screed. Approved hand-operated vibrators may be used in small, otherwise inaccessible areas.

b. (1) An approved finishing machine equipped with at least one screed shall be used. It shall comply with the requirements of Subsection 603.03 and the following additional requirements. The machine shall be inspected and approved in advance of the start of concrete placement.

(2) The finishing machine shall be self-propelled, capable of forward and reverse movement under positive control, and shall have provision for raising the screeds to clear the work when traveling in reverse.

(3) The finishing machine shall be equipped to travel on rails. Rails shall be sufficiently rigid that they will not deflect under the weight of the machine. Rails shall be securely anchored to provide stability in all directions. The method of anchoring shall not damage the concrete overlay. Supports for rails shall be fully adjustable (not shimmed) to obtain the correct profile.

(4) When placing concrete in a lane abutting a previously completed lane, that side of the finisher adjacent to the completed lane shall be equipped to travel on the completed lane.

(5) At least 1 oscillating screed shall be designed to consolidate the concrete by vibration to 98 percent of the maximum unit weight determined in accordance with NDR T 121. The degree of consolidation shall be measured by nuclear density methods in accordance with NDR T 525.

(6) A sufficient number of identical vibrators shall be installed such that at least 1 vibrator is provided for each 5 feet of screed length. The bottom face of this screed shall be at least 5 inches wide with a rounded or turned-up leading edge to minimize tearing the surface of the plastic concrete.

(7) Each screed shall weigh at least 75 pounds for each square foot of bottom face area and shall have positive control of the vertical position, angle of tilt, and the shape of the crown.

(8) Design of the finishing machine and associated equipment shall be such that positive machine screeding of the plastic concrete will be obtained within 1 inch of the face of existing curbs. The length of the screed shall be sufficient to extend at least 6 inches beyond the line where a saw cut is intended to form the edge of a subsequent placement and shall overlap the sawed edge of a previously placed lane at least 1 inch.

5. a. The Contractor shall proportion, mix, place, and finish at least 2.5 CY/h.

b. The finishing machine shall be operated so that the time between depositing the concrete on the deck and screeding shall not exceed 5 minutes.

711.04 -- Construction Methods

1. Concrete Removal Requirements:

a. (1) The Contractor shall remove, scarify, and/or chip the old concrete deck to the depths indicated in the plans and until all unsound concrete is removed. Where scarifying equipment cannot be used, hand chipping will be required.

(2) (i) At points where removal of unsound concrete is adjacent to reinforcing bars or the removal of active corrosion leaves over 67 percent of the bar diameter exposed, the removal shall be continued to a depth that will allow new concrete to bond to the entire periphery of the exposed bar.

(ii) At least 3/4 inch clearance shall be required around the bar.

(iii) Care shall be exercised to prevent cutting or otherwise damaging any exposed reinforcing bars.

(3) Any removals shall be carefully done to prevent damage to the bottom of the adjacent slab and to leave removal boundaries which will allow complete filling with plastic concrete.

(4) The Contractor shall take the necessary precautions to prevent damage to persons or property beneath the structure from falling rubble.

b. Removal work is divided into 3 classes according to the depth of material removed:

(1) Class I Repair - covers concrete removal from the deck surface to a depth shown in the plans (varies with each project).

(2) Class II Repair - covers concrete removal from the lower limit shown in the plans for Class I Repair to the mid-depth of the slab.

(3) Class III Repair - covers concrete removal depths from the mid-depth of the slab through the entire remaining deck.

c. Where machine scarifying is employed to remove concrete, extreme care shall be used to avoid cutting reinforcing bars. An occasional bar may be cut to as much as 25 percent of its diameter without impairing the structure, but if a substantial number of bars are damaged, machine scarifying will be prohibited and other methods required. Any damage caused by the Contractor shall be repaired by the Contractor at no additional cost to the Department.

d. (1) Wherever removal of unsound concrete extends to a depth exceeding 50 percent of the original deck thickness, the remaining thickness shall be removed to the full depth of the slab, and such areas of removal shall be classified as Class III Repair.

(2) When concrete removal is at approximately mid-depth of the slab, the Engineer shall determine if, in his/her judgement, the concrete quality and structural integrity of the remaining thickness requires full depth removal.

e. Any concrete removal which is necessary to allow striking the full required overlay thickness down to meet roadway joints, floor drains, or other fixtures will be considered to be Class II Repair.

2. Preparation of the Surface:

a. The Contractor shall sandblast and clean all exposed reinforcing bars, all prepared concrete surfaces, the portion of the bridge curb and all surfaces of steel roadway joints which will be in contact with the overlay concrete, and all edges of previously placed lanes not more than 24 hours before concrete placement.

b. In cases where the placement of the overlay concrete is delayed beyond 24 hours after the sand blasting has been completed, the formation of incidental rust on the rebars due to humidity or rain shall not be cause for re-sand blasting.

c. All debris and rubble resulting from deck removal shall be thoroughly swept up and disposed of in a manner satisfactory to the Engineer.

d. Any areas of the prepared deck surface contaminated by oil leaks or substances detrimental to the good bond shall be thoroughly cleaned by an approved detergent method or shall be removed to such a depth as may be necessary.

3. Proportioning and Mixing:

a. (1) The Contractor shall keep aggregate moisture content of successive batches within 0.5 percent.

(2) Continuous mixers shall be charged at the site or may be charged at other locations subject to the approval of the Engineer.

b. (1) The concrete, as discharged from the mixer, shall be uniform in composition and consistency. Mixing capability shall be such that finishing operations can proceed at a steady pace with final finishing completed within 10 minutes after depositing the concrete.

(2) Testing for slump from a continuous mixer shall commence within 2 to 4 minutes after the concrete is discharged and shall be performed as frequently as necessary to maintain control. The slump shall conform to the requirements of Section 1002.

(3) If required by the Engineer, uniformity tests shall be made according to ASTM C 685 and shall meet the requirements of ASTM C 685 Table A1.

4. Placing and Finishing Requirements:

a. (1) Longitudinal construction joints shall be located as shown in the plans. If not shown, locations will be subject to the Engineer's approval. Joints shall not be located in the traffic wheel paths.

(2) Transverse construction joints shall be avoided. If required, such joints shall be made against a bulkhead equal to the overlay thickness and installed to accurate grade and crown.

(3) Bulkheads or steel dam plates to be used at roadway joints shall be installed to accurate grade and crown.

(4) Rails for the finishing machine shall be set to the grade established by the Engineer to achieve the desired profile and to produce the minimum required overlay thickness over all points on the prepared deck surface. Before beginning concrete placement, a block with a thickness equal to the minimum overlay thickness shall be attached to the finishing machine screed and the machine operated over the prepared deck. All concrete failing to clear the block shall be removed.

(5) All reinforcing steel which does not have sufficient clearance shall be depressed and fastened down. If necessary, concrete shall be removed beneath reinforcing bars to allow depressing the bars. Concrete so removed shall be classified as Class II Repair. If the areas where reinforcing bars lack sufficient clearance are extensive, the Engineer may modify the profile grade to obtain the desired clearance without depressing the reinforcing bars.

(6) At transverse and longitudinal construction joints, the edge of the previously placed lane shall be sawed back to a straight and vertical edge before the abutting lane is placed. Slurry from wet sawing shall be thoroughly removed from the prepared deck surface.

(7) Forms shall be provided in areas of Class III Repair requiring full depth slab replacement. Forms for small areas (1 square yard or less) may be wired to the reinforcing bars for support. Forms for larger areas shall be supported by blocking from the beams.

b. The mixer may be positioned on the prepared deck to discharge the concrete directly in front of the finishing machine or may be located off of the bridge deck and the concrete transported to the finisher by means of an approved system. In either case, equipment and operations shall be closely observed to ensure that no foreign materials are brought onto the prepared and cleaned deck surface.

c. (1) Immediately before applying grout in preparation for placing new concrete, the surface shall be cleaned with air blast. To promote absorption of the grout, the surface shall be dry and not prewetted.

(2) Immediately ahead of concrete placement, the dry surface shall be thoroughly covered with a thin layer of grout. Grout shall be scrubbed into the surface with a stiff broom. The rate of progress in applying grout shall be limited so that grout does not become dry before being covered by the new concrete. Grout that is allowed to become dry and chalky shall be blast cleaned and replaced at no additional cost to the Department.

(3) The Contractor shall place concrete in a continuous operation throughout the pour. Fresh concrete 3 inches or more in thickness shall be internally vibrated in addition to surface screeding. The concrete shall be manipulated and mechanically struck off slightly above grade. It shall then be mechanically consolidated to the specified density and screeded to final grade. Hand finishing with a wood float may be required for producing a tight uniform surface. The provisions of Subsection 603.03, Paragraph 5. shall be strictly observed. The addition of water directly to the surface during the finishing operations will not be allowed. Use of approved admixture finishing aids is allowed.

(4) The Contractor shall test the floor surface for smoothness with a straightedge while the concrete is still plastic. For this purpose, the Contractor shall furnish and use an accurate straightedge 10 feet long, swung from handles 3 feet longer than one half the width of the floor.

(5) (i) The straightedge shall be held in successive positions parallel to the road centerline and in contact with the surface and the whole area gone over from one side of the floor to the other as necessary.

(ii) The straightedge shall be advanced along the deck in successive stages of not more than one half its length.

(iii) Any depressions found shall be immediately filled with freshly mixed concrete, struck off, and refinished.

(iv) High areas shall be cut down and refinished.

(v) The straightedge testing and refloating shall continue until the entire surface has no deviations from the straightedge that are greater than 1/8 inch and the floor has the required grade and contour.

(vi) When the required grade or contour of the floor is such that the use of a 10 foot straightedge is not feasible for testing the trueness of the surface, special tools shall be employed to ensure that there are no deviations in the required longitudinal grade or contour lines in excess of 1/8 inch in 10 feet.

(6) (i) A construction dam or bulkhead shall be installed when there is a 60 minute delay in placing concrete. The Contractor shall saw the end of the concrete to remove back to good concrete. Placement in this lane shall resume only after a period of 12 hours or may resume sooner provided a gap is left in the lane or strip being placed that is large enough for the finishing machine to clear the previously placed concrete.

(ii) During delays from 20 to 60 minutes, the end of the concrete shall be kept under wet burlap.

(7) (i) Individual areas of Class III Repair requiring full depth slab placement shall be poured on forms. Any areas exceeding 1 square yard will require 2-stage concrete placement. The first stage shall be poured up to the lower limit of Class I Repair area or to match adjacent areas of Class II Repair. This partial placement shall be made with Class 47BD-5,075 concrete in compliance with the pertinent provisions of these *Specifications*.

(ii) Partial placements shall be given a 72-hour wet-burlap cure and shall be surface dried, sandblasted, and cleaned before proceeding with the general concrete overlay.

d. The surface shall be textured with a wire broom or comb as prescribed in Subsection 706.03, Paragraph 8.b.(1-4).

e. As soon as finishing has been completed, all vertical joints with adjacent concrete shall be sealed by painting with thinned grout.

f. The surface shall be promptly covered with a single layer of clean, wet burlap. Care shall be exercised to ensure that the burlap is well drained and that it is placed as soon as the surface will support it without deformation.

g. The Contractor shall cure the concrete with wet burlap for at least 72 hours. The burlap shall be kept continuously wet by means of a sprinkling or wetting system. However, after 24 hours, the Contractor may cover the wet burlap with a layer of 4 mils (minimum) polyethylene film for a minimum of 48 hours in lieu of continuing the sprinkling or wetting system. The polyethylene film shall be fastened down along all edges throughout the curing period to prevent drying. Polyethylene film shall meet the requirements of Section 1010.

h. Hours during which the temperature is below 45°F will not be counted as acceptable curing hours, and the curing period shall be extended accordingly.

i. Failure to apply the wet burlap within 30 minutes after concrete has been deposited on the surface shall be cause for rejecting the work. If the concrete is revibrated due to failure to meet density requirements with initial vibration, this time limit may be extended 15 minutes. Surface concrete in a rejected area shall be removed and replaced by the Contractor at no additional cost to the Department.

5. Limitations of Operations:

a. The Contractor shall take every reasonable precaution to produce a smooth-riding concrete surface.

b. (1) Immediately after the curing period is completed, the Contractor shall test the deck surface for surface irregularities with a 10 foot straightedge or other device for measuring deviations from a plane. High spots in excess of 1/8 inch in 10 feet shall be marked.

(2) The Contractor shall eliminate such high spots by the use of approved grinding tools or other approved methods.

(3) The cause of such irregularities shall be determined and eliminated.

c. The surfaces adjacent to longitudinal construction joints shall match within 1/8 inch. Irregularities greater than 1/8 inch shall be removed by grinding to provide a smooth transition over the joint.

d. No loads other than construction equipment shall be allowed on any portion of the concrete deck which has undergone preparation and removal of the old concrete surface. No construction load will be allowed which exceeds either a 8,000 pound wheel load or a 16,000 pound axle load. Any combination of axles closer than 4 feet center-to-center will be considered to be 1 axle.

e. The bridge deck may be opened to traffic after the conclusion of the 72-hour curing period or the extended curing time, if necessary, due to low temperatures.

f. Adequate precautions shall be taken to protect freshly placed concrete from sudden or unexpected rain. The Engineer may order removal of any concrete damaged by rain.

g. Concrete shall not be placed at temperatures lower than 45°F. Placement may begin at that temperature if the temperature is predicted to rise and remain at least 45°F for the first 8 hours of the curing period.

h. High density-low slump concrete for bridge deck overlays shall not be placed when the anticipated wind velocity during the concrete placement period is expected to exceed the requirements shown in Table 711.03.

Table 711.03

Maximum Wind Velocity and Temperature	
Air Temperature In the Shade, (Degrees Fahrenheit)	Maximum Wind Velocity, (miles per hour)
86	10
75	15
65	20

i. (1) The high density-low slump concrete for bridge deck overlays shall not be placed when the ambient air temperature is above 86°F or the concrete temperature is above 86°F.

(2) Climatic conditions may require that concrete placements be made in the early morning hours or at night.

(3) The Contractor shall provide adequate lighting for all night work.

j. Concrete shall not be placed adjacent to a previously placed lane or strip which is less than 36 hours old. This restriction shall not apply to continuation of a lane or strip beyond a joint in the same lane or strip.

k. (1) Deck preparation work may be started in a lane adjacent to a newly overlaid lane on the day following the concrete placement provided no power-driven tools weighing more than 15 pounds shall be used.

(2) Power scarifying and all other preparatory operations may commence only when the previously placed concrete is at least 48 hours old.

(3) Curing shall be resumed promptly.

(4) The exposed surface shall be kept wet during the time it is uncovered.

6. The Contractor shall paint all exposed metal except weathering grade steel as prescribed in Section 709.

7. Density Tests:

a. The finished, in-place concrete overlay shall have a minimum density of 97.50 percent as determined by NDR T 525. The density tests will be made by the Engineer in "test wells" immediately after passage of the finishing machine.

b. (1) Test wells of sufficient size and depth are necessary for conducting density tests with the nuclear gauge. Test wells shall be approximately 10 inches x 10 inches and of sufficient depth that there will be at least 3 inches of concrete fill at these locations.

(2) The Contractor shall construct the wells. In each lane or strip of overlay placed, test wells shall be located at 5 foot intervals through the first 3 well locations, beginning at the start of the placement, and then at intervals not exceeding 50 feet through the remainder of the placement. Repair areas at these locations which will provide the sufficient depth of concrete may be substituted for test wells.

(3) The Contractor shall provide a suitable work bridge spanning the concrete placement area to facilitate the testing.

c. (1) Whenever a density test indicates a density less than 98 percent, the Contractor shall reverse the finishing machine to a point equidistant between the test well which produced the unacceptable density test and the nearest location at which an acceptable result was obtained.

(2) The Contractor shall then revibrate the overlay forward to the location at which the unacceptable test result was obtained, at which point a second density test will be made.

(3) Any revibration of previously placed concrete shall be completed before the concrete is 30 minutes old.

(4) Before resuming concrete placement, the cause of the unacceptable results shall be determined and corrected.

711.05 -- Method of Measurement

1. "Class I Repair", "Class II Repair", and "Class III Repair" will be measured for payment by the square yard of deck area repaired in accordance with each classification, as determined by field measurements.

2. "Placing, Finishing, and Curing HD Concrete Overlay" will be measured for payment by the square yard of deck surface overlaid as determined by field measurements.

3. "Concrete for Overlay - HD" shall be measured for payment by the cubic yard of concrete placed in the structure. This quantity will be determined from the established relation of concrete yield to the cement meter ticket printout of the properly calibrated continuous mixer. Unacceptable concrete and any waste shall be deducted from the volume for which payment is based.

711.06 -- Basis of Payment

1. Pay Item	Pay Unit
Concrete for Overlay - HD	Cubic Yard (CY)
Placing, Finishing, and Curing HD Concrete Overlay	Square Yard (CY)
Class I Repair	Square Yard (CY)
Class II Repair	Square Yard (CY)
Class III Repair	Square Yard (CY)

2. See Sections 602 and 603 for smoothness, quality, and thickness pay factors.

3. a. Payment shall be reduced when in-place density is less than the design density as determined by NDR T 525.

b. Payment shall be made as prescribed in Table 711.04.

Table 711.04

Density Pay Factor	
In-Place Density (Percent)	Authorized Payment as Percent of Unit Cost
100 to 97.50	100
Less than 97.50 to 97.00	50
Less than 97.00	0 (Reject)

c. For purposes of determining the quantity of deficient or unacceptable concrete, it will be considered that the density at any test well is representative of the material contained within a length of deck, for each individual width of placement, equal to the sum of one-half the distance to each adjacent test well.

4. a. Whenever a density test indicates a density less than 98 percent, a second test will be taken after reversing the finishing machine.

b. If the second density test indicates a density of 97.5 percent or greater has been obtained, the concrete can remain in place without a penalty to the Contractor.

c. If the second density test indicates a density between 97.00 percent and 97.49 percent has been obtained, that portion of the overlay can remain in place subject to the pay reductions described in this Subsection.

d. If the second density test indicates a density of less than 97.00 percent has been obtained, the work shall be discontinued and the concrete overlay removed back to a point equidistant between the test well having produced the density of less than 97.00 percent and the nearest location at which an acceptable density test was obtained.

5. Class 47BD-5,075 concrete used in partial placements is measured for payment by the cubic yard and included in the quantity "Concrete for Overlay - HD".

6. Payment is full compensation for all work prescribed in this Section.